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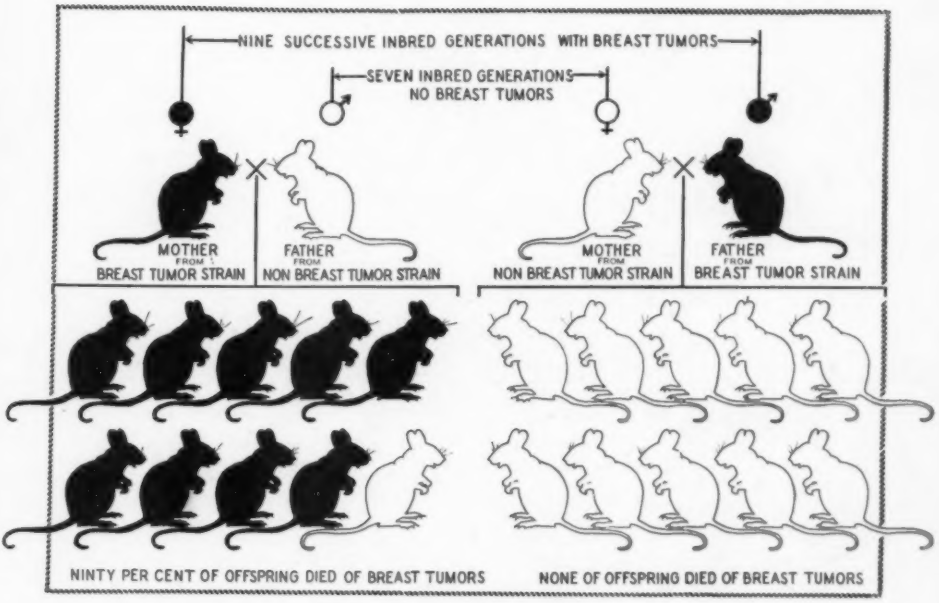
The Journal of HEREDITY


NINE SUCCESSIVE INBRED GENERATIONS WITH BREAST TUMORS
SEVEN INBRED GENERATIONS
NO BREAST TUMORS
MOTHER FROM BREAST TUMOR STRAIN
FATHER FROM NON BREAST TUMOR STRAIN
MOTHER FROM NON BREAST TUMOR STRAIN
FATHER FROM BREAST TUMOR STRAIN
NINTY PER CENT OF OFFSPRING DIED OF BREAST TUMORS
NONE OF OFFSPRING DIED OF BREAST TUMORS

MATERNAL INHERITANCE OF BREAST TUMOR

(SEE PAGE 391)

"Genetic Crime Factors" Suggested by Twin Studies
A Gene Inhibiting Anthocyanin Color in Rice
A New Lethal Gene in the Domestic Fowl
A Fragrant Double Nasturtium of 1730
First Court Test of a Plant Patent
Sterilization in South Dakota

VOLUME 27 OCTOBER, 1936 NUMBER 10

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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The

Journal of Heredity

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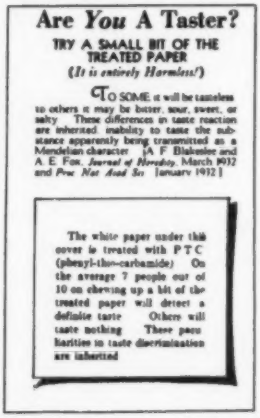
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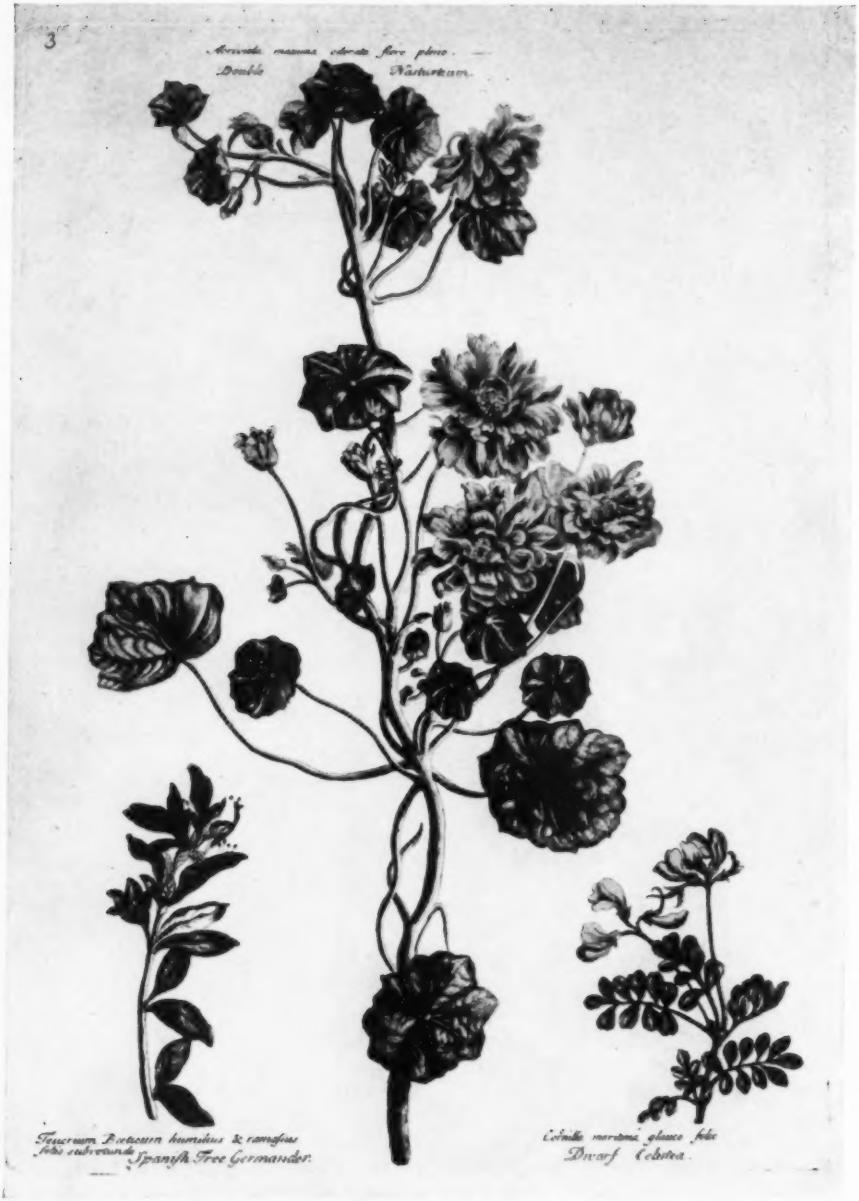


DOUBLE NASTURTIUM RECORDED IN EARLY PLANT VARIETY CATALOGUE

Frontispiece

In connection with the history of double Nasturtiums, the subject of an article and several notes in recent issues of the JOURNAL, this early record is of much interest. The volume in which it appears, the *Catalogus Plantarum*, was published in 1730 by the Society of Gardeners in London. This plate is also of interest as being one of the first colored illustrations ever to be printed,—by the mezzotint process, a forerunner of the halftone, in which the "dots" were made by mechanically roughening a copper plate. (See page 387.) Photograph courtesy of Mr. David Burpee.

THE EFFECTS OF STERILIZATION

As Shown by a Follow Up Study in South Dakota

J. H. CRAFT

State Commission for the Control of the Feebleminded, Redfield, South Dakota

SINCE 1917 the state of South Dakota has had a law providing for the sterilization of mental defectives. In 1925 a state program of social control of the mentally defective was put into operation. The sterilization law was revised at that time to conform to the program, the purpose of which was to prevent procreation by the mentally defective and to provide for their training, care and supervision. A State Commission for the Control of the Feebleminded was also created to develop and foster this program.

A recent report of the State Commission[5] shows that the program for the social control of mental defectives, which has been developed in South Dakota, includes the following phases: 1, Identification; 2, Classification; 3, Registration; 4, Education; 5, Segregation; 6, Sterilization; 7, Prevention of Marriage; 8, Supervision. The purpose of this study was to obtain information as to the types of patients who are sterilized, to determine the personal and social effects of sterilization upon the patients and its merits as a means of preventing the procreation of mental defectives.

The State Commission maintains a registry of all patients sterilized at the hospital of the State School and Home for the Feebleminded at Redfield, and of as many of the mentally defective patients sterilized in private hospitals as it can obtain. On January 1, 1936, this registry revealed that 248 patients had been sterilized at the institution and 21 at various private hospitals making a total of 269. This study is based upon the case histories of these 269 patients. A record of the operation, authority for sterilization, supervision, control, and a number of items of the personal and family history, was available at the registry. A personal call upon the patient and his nearest relatives or guardian was necessary to complete the case history and obtain a report of the personal effects of sterilization on the patient. A report on the cost of maintenance of the patients and their relatives during 1935 was obtained from the county welfare directors.

Legal Provisions

In South Dakota the law providing for sterilization applies only to those who are mentally defective and of procreative age. In its practical application only those who seem likely to have children are sterilized. Patients that are expected to remain in the institution for the feebleminded, those who are well supervised at home, persons who are nearing middle age without showing any tendency toward sex offences, and defectives who are physically incapable or so unattractive that mating is improbable are not sterilized. The cretin is sterile as are also most mongolians. Some patients who are committed for sterilization are found to be physically unable to undergo an operation without jeopardizing their lives or health. In such cases the physicians are given the legal right of discretion to postpone or not perform the operation.

The classification of intelligence is based upon the Binet tests. The sex and classification of the patients according to their intelligence is given in Table I. This table shows that of the 269 patients sterilized, 2 were idiots, 66 were imbeciles, 174 were morons, 24 were borderline, and 3 were dull. Of this number, 94 were males and 175 were females. The intelligence quotients range from 21 to 89. The mean IQ for the

group is 57.6. The standard deviation is 12.5.

The legal requirement that the patient must be of procreative age, of course, eliminates from sterilization all children who have not reached the age of puberty, and women who have passed the menopause. The youngest male was sterilized at fourteen years and three months and the oldest at sixty-three years. The youngest female sterilized was twelve years and five months and the oldest was forty-four years and five months. The mean age at the time of sterilization of the males was 25.1 years, and the females 24.0 years. The standard deviations are 10.2, and 8.2, respectively.

The mental defective who becomes delinquent is more likely to be sterilized than one whose behavior is satisfactory. Commitment for sterilization is often a part of the social treatment prescribed for sex offenders. Eighteen of the 94 males and 82 of the 175 females or a total of 100 of the patients were classified as "sex offenders" at the time of their sterilization.

The heredity of a mental defective is always a factor of practical importance to be considered in the matter of sterilization. An analysis of the reports of the cases of this study shows that 56 of the males and 107 of the females or a total of 163 have defective relatives registered with the State Commission. That is, 61 per cent of the patients are known to have blood relatives with defects that indicate morbid heredity. The defects of these relatives are classified and their relation to the patients is given in Table II. The list shows 278 mental defectives, 64 borderline, 21 insane, and 16 epileptics, making a total of 379 cases.

The family histories of nearly all of these patients are far from complete. Not a single blood relative of some of these patients is known to the State Commission. There are 12 orphans who were adopted into foster homes during their infancy. Records and investigations reveal little or no information about the antecedents of these patients. The records of 41 others have no information pertaining to their heredity and the writer was unable to obtain a report in this matter. Some of the relatives were reluctant to mention defectives who have died and there are, of course, many living relatives whose mental status could not be ascertained. One cannot say positively that any one of the patients does not have defective relatives.

Sterilization had its beginning in institutions for the care of defectives, and most of the operations for eugenic purposes are today performed in such institutions. Ninety-two per cent of the sterilizations in South Dakota have been performed at the institution for the feebleminded. Sterilization is a complement to segregation in a program of social control. There are, however, numerous instances where it serves the same purpose, namely, the prevention of procreation. A few of the sex offenders get beyond control at home and have to be returned to the institution for their own protection. The possibility of institutionalization is an aid to discipline in some cases. Most of the younger patients prefer their freedom, and when they realize that it is jeopardized by their own misdeeds it tends to hold them in restraint. At least, their relatives exercise more caution after sequestration and discharge. The actual number of successes and failures of this nature will be given later.

The type of home in which the mental defective lives is another determining factor in the selection of cases for sterilization. If the home takes good care of the patient and keeps him under supervision there is likely to be no complaint and the Sub-Commission is reluctant to incur the ill will of the relatives who can show that they are taking proper care of the patient. However, a number of relatives who provide better homes have brought patients to the hospital for sterilization as an added precaution when they fear that the patient might get out of hand.

Family Size

The frequency and number of siblings of 254 of the patients is given in Table III. The table shows that the 254 pa-

tients for whom the number of siblings has been ascertained have 1,319 full siblings and 171 half siblings, a total of 1,480 siblings and half siblings who were born alive. The average number of full siblings per patient is 5.2 and if the half siblings are included there are 5.8 per patient. If we include the patients and enumerate the offspring of their parents we find that the parents of these patients had 6.2 offspring per couple. If the half siblings are included the number of offspring is 6.8 for the parents and stepparents.

Ninety-three of the patients had become parents before they were sterilized. The 16 males of this group, who were married before sterilization, had 93 children which is 5.8 offspring per patient. The 51 married females had 263 children which is 5.2 offspring per patient. For both sexes there were 359 or 5.5 offspring per patient. Two unmarried males had one child each. Twenty-four unmarried females had 32 children. The married males had no illegitimate children, but the married females had 24.

The mean age of the married males at the time of sterilization was 39.4 years and the females was 29.0 years. The propagation of these patients would undoubtedly have continued for a number of years without sterilization.

In a study of the families that send students to the University of California, S. J. Holmes[3] found that the native born parents had an average of 2.4 offspring. These families were only 35 per cent as productive as the parents of the sterilized patients in South Dakota.

The marital status of the patients is given in Table IV. This table shows that 13 of the males are married, one is divorced, one is separated, one is widowed, and 75 are single. Among the females we find that 53 are married, six are divorced, six are separated, six are widowed, and 99 are single.

The 90 married patients (including three who have died) have been married from one to three times. The number of marriages with the frequencies is given in Table V. This table shows that two of the patients have been married three times, eight have been married twice, and 80 only once. There are 179 who have not married.

Some of the patients and their parents are concerned about having their opportunity for marriage jeopardized by sterilization. One male patient stated that a girl refused to marry him because he was sterilized. Just how serious the intent of this couple was in the matter of matrimony was not determined. The age of the one male married after sterilization was 24.5 years at the time of marriage. Twenty-two of the 73 married women have married since the operation. The age distribution of these women is given in Table VI. The mean age at the time of marriage of this group is 21.4 which is .2 of a year younger than the mean age of those who were already married before the operation. Two of the patients who were divorced at the time of sterilization have remarried. A further comparison of the age of marriage may be made with that of the mothers of the patients. The mean age of the mothers at marriage was 21.5. Thus we find that sterilization has not hindered many of the patients from marriage. How about the patients that are unmarried? Have they been hindered from marriage by sterilization? Only the one just mentioned has reported that it caused the loss of such an opportunity. The mean age of the 75 single males is 27.3 years. We found that the 16 men who married before sterilization were married at a mean age of 26.4 years. The unmarried men are .9 of a year older which is not a significant difference in so far as age is concerned. The mean age of the unmarried females is 23.9 years which is 2.3 years older than those who had married previous to sterilization and 2.4 years older than their mothers were at the time of marriage. Most of these patients were under state control and would therefore have been ineligible to marry if they had not been sterilized. After the operation they have again become eligible. There were a large number in the single group who were not likely to marry because of their mental condition. This handicap to mar-

riage appears to be greater for the men. Mentally defective men lack the aggressiveness required in the pursuit of a mate. They are further restrained by their lack of success as providers. Even the mental defective has some self imposed standards concerning the ability to provide for home and necessities of life that must be met before marriage. The mentally defective female is often acceptable as a wife regardless of her economic inadequacy.

A summary of the marital compatibility of the patients who were married at the time of this study is given in Table VII. This table shows that 39 of the patients are reported to be happily married, nine are doubtful, six are unhappy, and the status of 13 is unascertained.

A tabulation of the ability of the patients to work at the time of this study revealed that 74 of the males and 133 of the females were considered by the investigator as being "able to work," 16 males and 30 females were "able to work some," and one male and seven females were "not able to work." The one male classified as unable to work had reached an advanced state of schizophrenia. Of the seven females who were listed as unable to work, two had developed psychoses, three had serious epilepsy and two were so childish that they could not be depended upon to do the simplest tasks.

Relative Costs

A careful tabulation of the aid issued to the patients and their parents by the various relief agencies during the calendar year of 1935 was made. A summary of this tabulation shows that the single patients who were at large, and without parents, received an average of $251.14 per patient during the year. The married patients and their spouses received an average of $297.26 per couple. The parents of the patients received an average of $127.05. The per capita cost to maintain the patients in the institution for the feebleminded was $292.66. The average cost to maintain patients in their own homes were therefore less than would have been required to maintain them in the institution.

The average cost of sterilization for patients in private hospitals has been $95.00 per patient for women, and $25.00 for men. The average cost for both men and women at the institution was $22.82 per patient. There is an additional cost of transportation for those operated on at the institution which varies from meager charges by relatives to 15 cents per mile for officials.

All the operations for the males have been vasectomies. With the exception of one ovariectomy all the operations of the females were salpingectomies. All of the sterilizations performed at the institution for feebleminded were for eugenic purposes. Ten of the operations in private hospitals were for eugenic and the other 11 for therapeutic purposes. No deaths have been caused by these operations.

Only 16 of the patients were sterilized previous to 1929. The time interval since the operation for the 253 patients sterilized since 1929 is given in Table VIII. The actual range is from one month to seven years. The mean time interval is 41.4 months (approximately 3 years and 5 months for this group. The standard deviation is 23.6. This should be adequate time to be able to determine the effects of the operation upon the patient.

Effect on Patients

The patient's personal reaction to sterilization was obtained from 59 out of 94 cases among the males and 127 out of the 175 cases among the females of the total group. The reactions of eighty-three fathers and ninety mothers of the patients were also ascertained. The nature of these reactions is given in Table IX. There were 41 of the male patients who said they were satisfied with the operation; five were indifferent, and 13 were not satisfied. Among the females 98 were satisfied, 21 were indifferent, and eight were not satisfied.

An inquiry was made as to whether or not there had been any noticeable sexual changes following soon or at any time

after the operation. Reports for 70 of the males show that there were no recognizable changes in their sex life. Replies for 104 of the females show that the menstrual flow has continued for 98 and has discontinued for six. Five of the six had passed the menopause but the menses were normal until the menopause which came at about the usual age in life. The one patient who had an ovariectomy said that the menses had gradually ceased after the operation. Reports were obtained as to the change of libido for 55 of the married patients. Each of the 13 males and 42 females reports no change in libido.

Certain "armchair" critics have insisted that sterilization of mental defectives would have a tendency to increase sex offenses and cause the spreading of venereal diseases. A report of sex offenses and venereal diseases of the patients before and after sterilization is given in Table X. This table shows that 100 out of 258 of these patients were sex offenders before sterilization. Of this number only 11 have repeated the offense since sterilization. Three have begun offending since sterilization which makes a total of 14 per cent as many offenders for the 219 reporting as were found in this group before the operations were performed. The table shows that six had acquired gonorrhea and one had syphilis previous to the operation. Two have acquired gonorrhea and one has acquired syphilis since sterilization. The report indicates that there is but one in nine that has been a repeater, and one in 73 that has become an offender since the operation.

Sterilization can hardly be said to have any effect upon the moral conduct of mentally defective patients. They have so little inhibition in the matter of sex that the prospects of pregnancy and other undesirable consequences seem to have little or no influence. The fact that only one in seven of the patients has offended since the operation is probably due to better supervision after sterilization.

The State Commission makes an effort not to return sterilized patients to the community without some arrangement for their supervision. The status of supervision of the 269 patients is given in Table XI. This table shows that 159 are now under the supervision of the State Commission, and 43 are patients at the institution for the feebleminded. There are 25 others in the institution who have also been committed to the State Commission. Three patients are in the hospital for the insane, and 27 are in suitable homes with their parents or appointed guardians. There are eight who are dead. The whereabouts of four was unascertained. No effort is made in the case of those who have adequate care and protection in their own homes to have them committed to state supervision. However, most of those who have been sterilized since 1931 were first committed to state control. This procedure is advised in order to assure supervision in the event of the death of the parents.

The patients whose case histories are the objects of this study were sterilized for the purpose of preventing the reproduction of their own kind. This is an entirely effective means of control in so far as the patients themselves are concerned. Other members of these families, however, have the potentiality to produce more of the same kind. This trait of nature offers perhaps the most difficult handicap to sterilization as a means of complete social control of mental defectiveness. For the purpose of illustration of this handicap let us take from our cases one whose family history is better known. This family we may label as the *F B* (feebleminded-blind) family. This family is represented in Figure 1. The *F B* family had its beginning in South Dakota in about the year 1888. In that year a mentally defective woman came with her third husband to Dakota Territory to settle upon a homestead. A mature son by her first marriage came with this woman. At about the same time a married daughter also came with her husband who settled upon a homestead near that of her mother's family. Since that time three additional generations have been born and all of these descendants have contin-

Table I. The Classification of Intelligence and Sex of the Patients Sterilized in South Dakota, 1918-1935.

Sex	Idiot IQ 0-24	Imbecile IQ 25-49	Moron IQ 50-69	Borderline IQ 70-79	Dull IQ 80-89	Total
1	2	3	4	5	6	7
Male	1	26	57	10	0	94
Female	1	40	117	14	3	175
Total	2	66	174	24	3	269

Table II. The Number of Defective Relatives, and their Degree of Consanguinity to the Patients as Recorded by the State Commission.

Relation	Mentally defective	Border-line	Insane	Epil-eptic	Total
1	2	3	4	5	6
1. Grandparents	3	0	0	3	6
2. Fathers	15	1	5	1	22
3. Mothers	28	2	5	4	39
4. Uncles and aunts	15	2	2	6	25
5. Siblings	123	34	5	1	163
6. Cousins	34	8	3	1	46
7. Children	47	15	0	0	62
8. Nephews and nieces	13	2	1	0	16
Total	278	64	21	16	379

Table III. Frequency and Number of Siblings and Half Siblings of the Patients.

Number of siblings per patient	Siblings Frequency	Siblings Number	Half siblings Frequency	Half siblings Number	Total Number
1	2	3	4	5	6
Seventeen	2	34	0	0	34
Sixteen	1	16	0	0	16
Fifteen	1	15	0	0	15
Fourteen	4	56	0	0	56
Thirteen	1	13	0	0	13
Twelve	3	36	1	12	48
Eleven	2	22	1	11	33
Ten	13	130	1	10	140
Nine	21	189	0	0	189
Eight	10	80	2	16	96
Seven	23	161	1	7	168
Six	25	150	1	6	156
Five	25	125	5	25	150
Four	31	124	8	32	156
Three	32	96	3	9	105
Two	25	50	17	34	84
One	22	22	9	9	31
None	13		205		
Unascertained	15		15		
Total	269	1319	269	171	1490

Table IV. Marital Status of the 261 Living Patients on January 1, 1936.

Marital status on this date	Male	Female	Total
1	2	3	4
1. Married	13	53	66
2. Divorced	1	6	7
3. Separated	1	6	7
4. Widowed	1	6	7
5. Single	75	99	174
Total	91	170	261

Table V. Number of Times the Patients have been Married up to January 1, 1936.

Number times married	Male	Female	Total
1	2	3	4
Three	1	1	2
Two	1	7	8
One	15	65	80
None	77	102	179
Total	94	175	269

Table VI. Ages at Marriage of the 23 Patients who have Married since Sterilization.

Age	Frequency Male	Female
1	2	3
35-39	0	1
30-34	0	0
25-29	1	2
20-24	0	9
15-19	0	10
Total	1	22
Mean	(a)	21.4

a. Actual age 24.5 years.

Table VII. Marital Compatibility of Patients.

	Males	Females	Total
1	2	3	4
1. Happy	7	32	39
2. Doubtful	4	5	9
3. Unhappy	1	5	6
4. Unascertained	2	11	13
Total	14	53	67

Table VIII. Time Interval since Sterilization of Patients Operated upon from January 1, 1929 to January 1, 1936.

Time in months	Frequency
1	2
73-84	43
61-72	10
49-60	26
37-48	40
25-36	77
13-24	30
1-12	22
Total	248
Mean	41.4
Standard deviation	23.6

Table IX. Reaction of the Patients and their Parents to Sterilization.

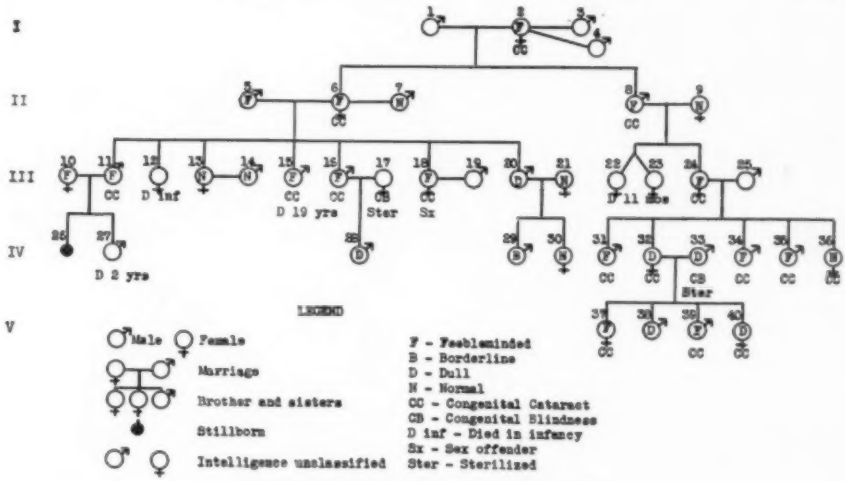
Reaction	Patient Male	Patient Female	Patient Total	Parent Fathers	Parent Mothers	Parent Total
1	2	3	4	5	6	7
1. Satisfied	41	98	139	64	66	130
2. Indifferent	5	21	26	12	8	20
3. Not satisfied	13	8	21	7	16	23
4. Reaction unascertained	32	43	75	77	89	166
5. Dead	3	5	8	109	90	199
Total	94	175	269	269	269	538

Table X. Sex Offenses and Venereal Diseases Acquired Before and After Sterilization.

Order of offense	Sex Male	Sex Female	Both sexes	Total No of-fense	Unascer-tained
1	2	3	4	5	6
1. Sex offender previous to sterilization	18	82	100	158	11
2. Sex offenses repeated after sterilization	1	10	11	208	50
3. Sex offending begun after sterilization	1	2	3	216	50
4. Acquired gonorrhea before sterilization	1	5	6	255	8
5. Acquired syphilis before sterilization	1	0	1	261	7
6. Acquired gonorrhea after sterilization	0	2	2	221	46
7. Acquired syphilis after sterilization	0	1	1	222	46

Table XI. Means Provided for Supervision of the Patients.

Means of supervision	Male	Female	Total
1	2	3	4
1. State Commission	47	112	159
2. State institution for feebleminded	18	25	43
3. State Commission and institution	10	15	25
4. State institution for insane	3	0	3
5. Parents or appointed guardian	10	17	27
6. Dead	3	5	8
7. Unascertained	3	1	4
Total	94	175	269



FIVE GENERATIONS OF DEFECT

Figure 1

The history of the *F B* family in South Dakota runs through five generations of feeblemindedness (*F*) and defective vision (congenital cataract—*CC*). In such instances of morbid heredity, where pedigree data are available to show several generations of multiplying defect, sterilization has a definite place in the conservation of human germ plasm. (Note: Individual 11 in generation III is sterilized, in addition to those so marked in this chart.)

ued to live or have died in the state.

The chart tells a story of the transmission of congenital cataract and mental defectiveness to the four generations of descendants of this one woman. In the chart each individual born and the persons whom they marry are represented by numbers which will be used to refer to specific individuals. The original settler is *2*. She is represented as the parental generation. We note that *2* was mentally defective and had congenital cataract. The next generation is represented by *6* and *8*. Both this daughter and son are mentally defective and have congenital cataract. In the second generation, among the grandchildren of *2*, we find that *6* and *8* had a total of ten children. In this generation five are mentally defective and have congenital cataract. One child (*12*) of *6* and twins (*22, 23*) of *8* died in infancy. One illegitimate daughter of *6* (*13*), is normal mentally and has good vision. One son (*20*) is dull mentally but has normal vision. In the third generation there was one stillbirth (*26*); one child (*27*) who died at two years of age, and eight who survive. In this generation three are mentally defective, one is borderline, two are dull, and two have normal intelligence. Five have congenital cataract. The ages of this group vary from three (*30*) to twenty-six years (*31*). In the fourth generation, two are mentally defective and two are dull. Three have congenital cataract. To summarize we find that there are 13 mentally defective and 16 with congenital cataract among the 22 persons who survive at present or have lived beyond infancy.

Various authorities on heredity have studied the apparent character of genes that transmit both the traits of congenital cataract and mental defectiveness so manifest in the *F B* family history. Guyer[2] has pointed out the dominant tendency of congenital cataract. East and Jones[1] assumed the recessive character of feeblemindedness. Popenoe[4] has indicated the probability that "intelligence in general is due to multiple genes." Other authorities have suggested the multiple recessive character of genes in mental defectiveness.

Among the descendants of *2* in genera-

tions II to V the matings of congenital cataract × normal produced the following progeny: 15 with congenital cataract: 4 normal: 5 died in infancy. This distribution departs considerably from the 1:1 ratio of normal and affected expected in such matings—unless we include all those who died in infancy with the normals. This is due mainly to the fact that all five children of *24* were affected. In view of the small numbers involved such a departure from expectation may legitimately be ascribed to chance.

The individuals that did not have this eye defect have produced children of normal vision. If those in this family who showed this visual defect were not to have children congenital cataract would undoubtedly be eliminated in this family. How this may occur in the *F B* family we shall find further on.

The mental defectiveness, being a multiple recessive character, can not be traced so distinctly as the congenital cataract. Because there is more than one determiner for this defect its distribution is irregular. When feebleminded have mated with persons of normal intelligence (dominant to mental defectiveness) the tendency is to produce children of normal intelligence. However, the mentally defective do not tend to marry normal persons. Their tendency is to marry persons of mentally defective, borderline, dull, and occasionally normal intelligence in such a way that there is an intermingling which produces offspring of various levels of intelligence but with a predominance of individuals showing borderline mentality.

The State Commission began to interfere with the reproduction of the second filial generation of the *F B* family in 1931. Even before this time other factors had interrupted the normal reproductive expectation of this family.

In 1933 *11* was sterilized. His only child had died in early childhood. His sister, *13*, is normal and married a normal man, but had no children. She is now 46 years old. A brother, *15*, died in his youth. The wife of *16* was sterilized in the course of a Caesarean section at the birth of their only child. There is reason to believe that *18* is now sterile. She is divorced but under state control. The dull *20* is married to a normal woman and has two children. The mother of five children, *24*, has passed the menopause. Of the children, *31*, *34*, and *35* are under state control. Another daughter, *32*, is married to a partially blind man and has four children. Her husband (*33*) recently volunteered for sterilization.

A bit of friendly cooperation on the part of the social case worker and members of this family may eliminate the congenital cataract in this family. Of those who may transmit the congenital cataract only *36* and *40* are not eligible for state control. However, the supervisor may be able to persuade these two of the advisability of sterilization when they are older. Several members of the family are conscious of the hereditary nature of the defect and have expressed the desire not to transmit it to children of the next generation. There is no such simple method of control for mental defectiveness. There are *28*, *29*, *30*, *36*, *38*, and *40* who are not subject to control. As "carriers" they may be able to continue the mental defect in future generations in some unpredictable ratio. However, this program is directed toward the prevention of the procreation of mental defectives. In attaining this objective sterilization is manifestly successful.

Summary

A total of 269 patients have been sterilized in South Dakota. Of this number 94 were males and 175 were females. The mean IQ of this group is 58.

The patients have 379 relatives who are known to be defective mentally. This indicates a tendency toward a pronounced morbid heredity for this group.

The parents of the patients have an average of 6.2 offspring. The 93 married patients had an average of 5.5 children per patient before sterilization. These patients were in the early thirties and would have produced larger families if they had not been sterilized. The par-

ents of University of California students were found to have 2.4 offspring which indicates that they are only 35 per cent as prolific as the parents of the sterilized patients in South Dakota.

The sterilized patients who were at large received an average of $251.14 from relief agencies in 1935. The married received $297.26 per couple and the parents of the patients at home received an average of $127.05. The per capita cost of maintenance for patients at the state institution for the feebleminded was $292.66.

None of the patients was found to have had any sexual changes that had been caused by sterilization. The married patients have experienced no change in libido.

There were 100 patients who were listed as "sex offenders" previous to sterilization. Of this number seven had venereal diseases. There were eleven patients who have repeated and three who have begun sex offending since sterilization. The ratio of offending before and after sterilization is seven to one. The reduction of sex offenses after sterilization has been attributed to better supervision.

The report of the *F B* family indicates the difficulties of control of mental defectiveness because of its recessive hereditary character. However, sterilization as applied to members of this family indicates its possibilities as a phase of the social control of mental defectives.

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✦

The Catalogus Plantarum of 1730

THE publication from which was reproduced the double nasturtium appearing as the Frontispiece has a number of interesting features. Published 23 years before Linnaeus' *Species Plantarum*, it represents a sincere attempt to to systematize and summarize existing knowledge concerning plants to be found in gardens in the neighborhood of London. The Preface points out at length that many botanical books were available, but that the authors of these had since ancient times been copying each other's errors so that it was impossible to tell where fact ended and fancy began. The Committee appointed by the London Society of Gardeners to prepare this work held monthly meetings for five or six years, at which meetings the plants themselves, and not what had been written about them, was discussed and put on record. The Committee appears to have done an excellent job of sticking to bare facts, leaving speculation and myths to others.

A noteworthy feature of this volume is that it is to a remarkable extent a compendium of introduced plants. In the dedication to the Earl of Pembroke and Montgomery it is stated: "As the design of this work, is to promote the introducing among us such foreign trees, as may contribute either to usefulness or delight; so we concluded we could no better recommend it to the world than under the protection of so good a judge and encourager as yourself." Later in the introduction is given a list of early plant introducers, "from whose generosity the several English gardens have been supplied with a great number of trees, plants, flowers, etc." Even at that time plant introduction was specialized, and the field of each of these "Patriots of Horticulture" is given in some detail.

Especial mention is made of the Worshipful Company of Apothecaries of London which had established a public botanic garden at Chelsea devoted to

(*Continued on page* 400)

TWINS AND CRIMINALS

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TWINS are brought up in identical circumstances to a greater extent than ordinary brothers and to a vastly greater extent than any two persons selected at random.

But while both members of a pair of twins have, in most instances, the same environment, they do not necessarily have the same heredity.

Identical twins, who make up one-fourth or one-third of all, do have virtually the same heredity because they are, so to speak, halves of the same original person. But ordinary twins have no more resemblance genetically than ordinary brothers and sisters; they may even be of opposite sexes.

The more frequently identical twins are found to be alike with respect to any given character, while ordinary twins are unlike with respect to the same character, the more strongly is the character in question evidently determined by inheritance. For if it were determined by environment, the ordinary twins should be about as much alike with respect to it as are the identical twins.

This principle, applied with great success in research by Francis Galton, has been developed more fully in recent years, until it has become one of the most dependable methods of studying human heredity. Its application to the study of criminality has helped greatly to clarify this difficult subject.

Criminal Twins

At first sight it appears absurd to talk of the inheritance of criminality, since this a social, not a biological, concept. Many writers assume without hesitation that criminality is simply the result of evil influences, bad example, and neglect. Anyone, in the wrong surroundings, may become a criminal: and they like to quote the remark of an ancient Greek (since borrowed by or ascribed to innumerable others) as he looked at the criminal on his way to punishment, "There, but for the grace of the High Gods, go I!"

Others lay stress on the frequent arbitrary or artificial nature of punishable offenses. A few years ago the man who had a bag of gold in his safe was a thrifty and praiseworthy citizen; today he is a criminal.

This interpretation has been confronted in recent years by four studies[1, 2, 3, 5] of criminal behavior in twins. These studies have challenged the current environmentalist interpretation, and require a definite modification of it. The latest of these studies[1] is by Dr. Heinrich Kranz, assistant in the neuropsychiatric clinic of the University of Breslau, Germany. He has collected detailed histories of 75 pairs of twin brothers, together with 50 pairs of opposite-sexed twins who are thrown in for good measure.

The prerequisite to any use of this method of research is exact diagnosis of the identity of the twins. No one has gone farther for this purpose than Dr. Kranz, who has called to his assistance specialists in a number of techniques. Hair form and color, eye color, form of nose, ear, jaw, tongue, face, and skull; general body build; finger-prints, blood types, have all been compared carefully, together with the usual anthropometric measurements. Only 7 cases remained in doubt; and the author gives in detail the reasons for his decision in each of them.

In each of these cases, it will be recalled, one of the twins was a criminal. If the other also had a criminal record, the pair is described as concordant; if not, it is discordant. Dr. Kranz' twins are tabulated, from this point of view, as follows:

Type	Number	Concordant	Discordant
Identical	32	21=66%	11=34%
Ordinary	43	23=54%	20=46%
Opp. sex	50	7=14%	43=88%

The opposite sexed pairs may be left out of the further discussion in this brief review, since social conditions surrounding women are different from those surrounding men, and these pairs cannot be compared directly with the others.

When consideration is limited to the pairs of like-sexed twins, it is evident that about two-thirds of the identical twins are concordant, but only a little more than one-half of the ordinary ones. The difference suggests strongly the presence of genetic forces that determine criminal behavior in the ordinary circumstances of daily life.*

Most of Dr. Kranz's book is given up to the detailed and interesting life histories of all these twins. The details accentuate the differences shown in the bare statistics. When the nature and the frequency of offence, the amount of penalty, and the age of entry on a criminal career are compared, it is seen that the concordant identicals are much more like than the concordant ordinary twins. Some of the latter, indeed, are concordant only in the fact of having each at least one conviction; and in other respects have such different histories that it is a fair question whether they might not better be called discordant.

The material did not throw as much light as might be desirable on the development of twins reared apart. Most of the twins were together during their school years, and then separated as they took up their life work. Those who were together indefinitely did not show much difference in resemblance of careers from those who were early separated geographically. This was true alike of the identical and the ordinary twins.

Twins Living Apart

Veit and Stefan Walther, for example, are identical twins, now 58 years old, sons of a day laborer, and separated almost continually since school days. Each had difficulties with his teachers, with his officers during the war, and with the civil authorities wherever he went, usually for theft, begging, or vagrancy. Each had an unsuccessful early marriage and each in later life remarried, the second wife in each case being 23 years old and the husband old enough to be her father. Veit has piled up a record of 59 convictions; Stefan, with only 23, has had either a quieter life or better luck.

Fritz and Stanislaus Igel, now 48 years of age, illustrate the same point. They are identical twins, sons of a law-abiding coachman, who have been separated since the age of 15. Simple, weak fellows, they have a strong propensity to burglary and theft. They married at the same time, and their marriages have followed similar troubled courses. Their military careers (entirely separate) were similar in lack of discipline and its consequences. Fritz is a little more energetic than his brother; otherwise their careers have run parallel though far apart.

As a psychiatrist, Dr. Kranz is not satisfied with a merely statistical treatment, but reviews the histories to see whether they suggest any particularly important factors that have led the subjects into criminal ways and ended with their conviction.

Size of family, birth order, and birth injury seem to have no general importance. Physical disease occasionally seems to be a factor, tuberculosis somewhat unexpectedly being assigned weight as tending to diminish self-control. Feeblemindedness and alcoholism are closely associated with crime, as are a number of neurotic, psychopathic, and epileptic tendencies.

Differences in training, discipline, and parental management are then examined. In some instances these appear to be associated with differences

* Dr. Fritz Lenz, in a recent paper[4], argues that "the significance of heredity is much greater than the study of twins in recent years seemed to demonstrate."

in later criminal behavior, in others not. It seems necessary often to conclude that it is the character of the child who receives the training, rather than the training itself, that is significant.

Sexual histories differ as do criminal histories, leading to the conclusion that a man's sexual life is also governed largely by his inherited constitution.

Finally, Dr. Kranz considers the "equivalents of criminality." A mere record of conviction is not the only fact of importance. It is perhaps not the fact of greatest importance. A man might by good luck escape arrest; yet his whole career might show that he was really a "born criminal." Such records are considered by the author under the heading of "equivalents of criminality." He concludes that in the discordant identical twins, the career of the non-criminal brother is often such as to indicate his essential likeness to the convict. "Concordance in ordinary twins means, on the whole, something different from concordance in identical twins. Concordant identical twins are much more alike than concordant ordinary twins. There can no longer be any doubt of that fact."

All these findings are in general agreement with those of the authors who have attacked the same problem in the same way. The following table summarizes the four studies previously mentioned:

Author	66 Identical Twins		84 Ordinary Twins	
	Concordant	Discordant	Concordant	Discordant
Lange	10	3	3	15
Legras	4	0	0	5
Stumpfl	11	7	7	12
Kranz	20	11	23	20
	45	21	32	52
Per Cent	68%	32%	38%	62%

Further studies of the same sort will be made; but the fact that each of these four studies finds the conclusions pointing in the same direction is sufficient to give one some confidence in the results reached.

Dr. Kranz concludes cautiously that in the light of all these studies, "we must ascribe to heredity a more important rôle in the production of crime, than has hitherto been the case."

This does not require the adoption of a predestinatarian philosophy. "Crime is destiny," to quote the title of Dr. Lange's pioneer study of twins[2] in this connection; but heredity cannot be made exclusively responsible for destiny. The discordant identical twins show that other facts than the genetic constitution are concerned with criminal behavior—as everyone has always known.

In discussing the applications of the findings, the author suggests the desirability of sterilization for the feebleminded, the chronic alcoholic, and the criminal psychopaths who are on the borderland of the great psychoses. Sex offenders also seem to be particularly characterized by biological inferiority—often mental deficiency—and eugenic measures will help to reduce their number.

It is the chronic and biologically inferior criminal, Dr. Kranz seems to think, who has found his destiny largely limited and directed by his heredity. Aside from these "there remains a large part of the criminal population, which owes its one misstep or its unfavorable curve of life to physical damage, strong inciting factors, and an especially unfavorable environment. These are the cases with good future prospects, whose heredity value is not to be measured by the fact that they deviated into crime."

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THE SPONTANEOUS TUMOR INCIDENCE IN MICE

I. "Z" Stock × "I" Stock

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IN A preliminary report[6] the staff of the Jackson Memorial Laboratory advanced the theory of the extra-chromosomal influence in determining the incidence of mammary gland tumors in mice. Several reciprocal crosses were made in which individuals of lines having a high mammary gland tumor rate were mated to representatives of low tumor strains. In every cross the proportion of mammary gland tumors was greater in hybrid generation animals when the parent animal from the high tumor stock was a female.

The results obtained in one cross have been verified by Korteweg.[3]

Further data have been reported by Murray and Little[4, 5] on the results secured from the F_2 and back-cross generations of the cross dilute brown × C_{57} black.

Reciprocal F_1 breeding females between two high tumor strains gave results which probably had the same explanation.[2]

In this article we wish to give additional observations on the cross between the *Z* and the *I* stocks.[6] While the number of animals is small, the results are consistent with other experiments. All the females were used as breeders.

The author is indebted to Dr. A. M. Cloudman for the pathological diagnosis of the material.

Stocks of Mice

(1) The *Z* or *C*$_3$*H* high tumor line has been inbred since 1918. Seventy-eight per cent of the breeding animals living four months or longer develop mammary gland tumors.[1] The mean tumor age is 10.7 ± 0.16 months.

The ancestry of the ten females of the *Z* stock which were outcrossed is represented in Chart I. The numbers preceded by *"S"* are from the series of Dr. L. C. Strong, from whom the writer obtained the strains. Five of the animals died cancerous, two were discarded when they were 6.5 months old, two died non-tumorous at 8.0 and 10.5 months, and one was missing when 9.5 months old. Four of the females which died cancerous were representatives of the eleventh successive generation of cancer.

(2) The pedigree of the *"I"* strain is given in Chart II. Two females, No. 22262 and No. 22263, were mated to *Z* stock males. They died non-tumorous at 15 and 16 months respectively. No tumors had been recorded in the ancestry of these two mice for eight generations, the average age at death being 13.7 months. However, two sisters of the above mentioned females developed tumors; No. 22261 with an adenoma of the stomach at 19.5 months, and No. 23446, in a later litter, with an adenoma of the stomach. Male No. 23447 died at 11.0 months from an embryonal cell carcinoma of the testis. This stock was discontinued before a large number of animals had been obtained. No mammary tumors were observed in the small number of mice we raised.

Observations

Thirty-six ZIF$_1$ (*Z* ♀ × *I* ♂) breeding females survived five months or longer. They are tabulated in Chart 3 according to the mothers from the *Z* stock. The age and cause of death is also given. Thirty-three or 91.7%

Chart I. Ancestry of the cancerous Z or C$_3$H stock (Reading from the bottom). The females which were outcrossed to the "I" stock are represented with underlined numbers. The age at death is given for the cancerous ("C") and non-tumorous mice ("D")

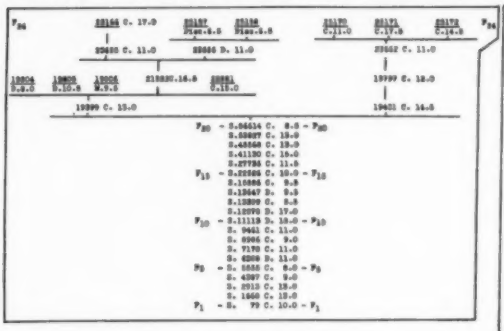
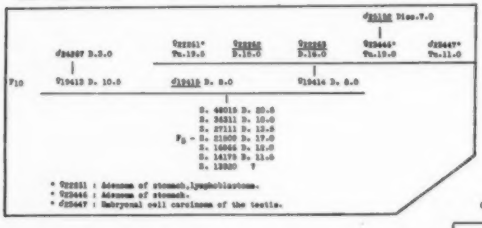


Chart II. Ancestry of the "I" stock which was outcrossed to the Z or C$_3$H strain.



* ♀22251 : Adenoma of stomach, Lymphoblastoma.
* ♀23446 : Adenoma of stomach.
* ♂23447 : Embryonal cell carcinoma of the testis.

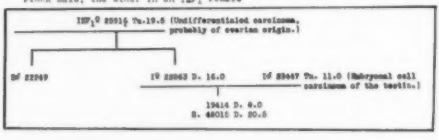
Chart III Tabulates the IZF$_1$ females

Parents	Ca. F$_1$ Progeny Age At Tumor	Non-Ca. F$_1$ Progeny Age at Death
♀ 19804 x ♂ 19815 D. 8.0 D. 8.0	22897 - 8.0 22880 - 10.0 22899 - 10.5 22900 - 7.5 23646 - 7.0	
♀ 19806 x ♂ 19815 D.10.5 D. 8.0	21837 - 9.0 21839 - 13.5 22898 - 7.5 24359 - 9.5	21835 - N. G.S.,Abscess 24507 - N. G.S.,Abscess
♀ 19806 x ♂ 19815 M. 9.5 D. 8.0	21842 - 10.5 21845 - 11.0 21846 - 11.0 24472 - 10.0 24474 - 8.5 24475 - 13.0	
♀ 22881 x ♂ 24057 C.15.0 D. 8.0	23478 - 11.0	
♀ 23146 x ♂ 23447 C.17.0 Tm.11.0	22230 - 14.0 22210 - 13.5	
♀ 22189 x ♂ 22182 Disc. Disc.	22743 - 14.0 22745 - 16.5	
♀ 22189 x ♂ 22182 Disc. Disc.	22746 - 17.5 22749 - 14.5 22731 - 8.0 22733 - 11.0 22776 - 9.0	
♀ 22179 x ♂ 23447 C.11.0 Tm.11.0	22734 - 13.0 22737 - 8.0	
♀ 22171 x ♂23447 C.17.5 Tm.11.0	22736 - 9.5 22813 - 8.0 22818 - 13.0	22814 - S.G.,Missing.
♀ 22172 x ♂ 23447 C.14.0 Tm.11.0	22725 - 8.0 22752 - 7.5 22827 - 10.0	

Chart IV Parents, age and cause of death of ten IZF$_1$ females. The average age at death was 22.5 months

Parents	IZF$_1$ Progeny	Age at Death	Diagnosis
♀ 22263 x ♂ 22249 D.15.0	22910	11.0	Lymphoblastoma.
	22913	23.5	P.M. changes. Gross:enlarged spleen. Path.: Marked necrosis with bacterial infiltration.
	22914	23.0	Cavernous hemangioma.
	22911	27.0	Lymphoblastoma.
	22916	19.5	Undifferentiated carcinoma,probably of ovarian origin,with some evidence of gland formation. Invading muscle of uterus region.
	22917	23.5	P.M. changes. Gross:enlarged spleen.
♀ 22262 x ♂ 22249 D.15.0	24027	27.5	Lymphoblastoma.
	24028	23.5	P.M. changes. Gross:enlarged spleen.
	24029	19.0	Lymphoblastoma.
	24030	18.0	Fibrosarcoma.

Chart V Pedigree relationship of the two genital tumors, one in an "I" stock male, the other in an IZF$_1$ female



PEDIGREES OF MICE USED IN CROSSES

Figure 1

These pedigrees (Charts I and II) emphasize the differences of the two strains with respect to type of tumors manifested. Nearly 80 per cent of *Z* strain females die of mammary gland tumors, while no ancestors of the *I* strain mice used in this cross had died of tumors for eight generations. In crosses between these two strains, 90 per cent of the offspring of *Z* strain mothers died of mammary gland tumors, while *I* strain mothers produced offspring none of which died of mammary tumor, though some died at a much later age, of internal tumors.

developed mammary gland tumors at a mean age of 10.4 ± 0.4 months. The youngest to be observed with a tumor was 5.5 months; the oldest 17.5 months. Of the three non-tumorous mice two were killed and one was missing at ages below the mean tumor age.

In the reciprocal cross observations are available on only ten mice (Chart IV). They were descended from the *I* stock females No. 22263 and No. 22262. Lymphoblastomas were observed in four animals at an average age of 21.1 months, one of which was only 11 months old at autopsy. Three other mice were also cancerous: fibrosarcoma at 18.0; cavernous hemangioma at 25.0; and the third with an undifferentiated carcinoma, which

was probably of ovarian origin, at 19.5 months.

The other three IZF_1 females died at the ages of 23.5, 23.5 and 30.5 months or an average of 25.8 months. Post mortem changes were so far advanced when autopsies were made as to make pathological diagnosis impossible. The mice showed however some enlargement of the spleen, a symptom suggestive of lymphoblastoma.

The average age at autopsy of the seven cancerous animals was 21.0 months. If the non-tumorous animals are included the average age at death of the IZF_1 mice was 22.5 months. No breast tumors were observed.

The pedigree relationship between the testicular and ovarian tumors is given in Chart V. An embryonal cell tumor of the testis was removed from the *I* stock male No. 23447. A sister in a previous litter, No. 22263, was mated to a male from the *Z* stock. One of its F_1 progeny, No. 25916, developed an undifferentiated carcinoma which was probably of ovarian origin.

The *I* stock male No. 23447 was mated to *Z* stock females to make ZIF_1 hybrids. Ten of the eleven progeny in the first filial generation developed breast tumors at an average age of 10.7 months. Four of the animals lived longer than 11 months, the age at which No. 23447 was observed with a tumor.

Summary and Conclusions

Further observations on reciprocal crosses between a high mammary tumor line and a stock showing internal but no breast tumors gave the following results in breeding females of the first filial generation:

(1) When the maternal parent was from the mammary tumor stock, 33 of 36 F_1 females developed breast tumors at a mean age of 10.4 months.

(2) When the maternal parent was from the stock which developed internal tumors, 7 out of 10 hybrid females were observed with various types of internal tumors at an average age of 21.0 months.

(3) The appearance of lymphoblastomas, fibrosarcoma, and other internal tumors was observed at a significantly later age than were mammary gland tumors.

(4) Further verification is given to the theory that extra-chromosomal influence is chiefly involved in the production of mammary tumors in mice.

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Wisdom Needed

The bulk of scientific effort is, and always has been, directed toward analysis unaccompanied by synthesis. Scientific men have mainly left it to philosophers and literary men to be the synthesizers of their data, shirking the task themselves with a few notable exceptions, of whom perhaps the greatest was a biologist, Charles Darwin. But analysis at best leads only to knowledge; while synthesis may furnish wisdom. And mankind sorely needs more wisdom right here and now!—Raymond Pearl.

PLANT PATENT 110 DECLARED INVALID

First Judicial Decision Suggests Trouble Ahead for Plant Patentees—Need for a Realistic Revision of the Existing Bio-legal Graft Hybrid

SIX years after the adoption of the Plant Patent Amendment, the first court test of the law has resulted in a decision invalidating Plant Patent 110. This patent was granted to M. H. Horvath on October 23, 1934, on an erectly growing form of *Berberis thungbergi*. According to the patent specification Mr. Horvath selected upright growing seedlings for five generations, and in the sixth generation obtained the perfectly erect plant which is the basis of the new variety. It is said to be hardy in Ohio and rust immune. When asexually reproduced the erect growth habit is uniformly transmitted in the cuttings.

The patent was sold by Mr. Horvath to the Cole Nursery Company of Painesville, Ohio. About a year ago this company sued the Youdath Perennial Gardens, Inc., for infringement, alleging that the Horvath variety was being sold by the latter corporation in violation of the patent. Decision of the U. S. District Court of Eastern Ohio has just been entered. Its text is as follows:

The suit is one for infringement, injunction and accounting for damages and profits in respect to Plant Letters Patent No. 110 issued to Horvath and assigned to the plaintiff. Invalidity and non-infringement are the main defenses to the Bill. Defendant also asserts failure to prove corporate capacity of the plaintiff and failure to prove assignment, both of which are denied by answer; but the primary questions upon which the controversy turns are prior public use and infringement.

"Berberis Thunbergi Pluriflora Erecta" is the botanical name of the patented plant made the subject of Plant Patent No. 110 granted to Horvath on October 23, 1934, on an application filed July 19, 1934. For the purpose of decision, it will be assumed that such a patent is authorized by Title 35, Sections 31 and 40, United States Code as amended 1930. But if the facts reveal that the plant was introduced to the public prior to May 23, 1930, there is no occasion for further consideration of the validity of the patent. See Title 35, Section 32a. Nor is there necessity for such consideration unless the proof shows that the plant was not in use for more than two years prior to the application of July, 1934.

Horvath, the inventor and assignor of the plaintiff, testified that he began developing the upright barberry in 1910, when he discovered that one of a great number of Japanese barberry plants had peculiar upright growing characteristics; that by a process of selection and genetics through five generations of seedling planting and growth, he finally asexually produced in the winter of 1923-24 a new barberry having novel features not known before, and which could not be duplicated save from cuttings of his plants thus produced. The charge is that the defendants obtained their plants from cuttings of the plaintiff's, because that constitutes asexual reproduction, and in no other way could the alleged infringing plants have been produced.

From a consideration of all of the evidence upon the subject, I feel unable to say that it would be impossible to reproduce or duplicate substantially the character of plant of the plaintiff without cuttings from the Horvath plants. Conceding that the plants of the plaintiff and of the defendants have similar characteristics, the proof is not clear and convincing that the plaintiff must have appropriated plants or cuttings belonging to Horvath or his assignee.

The use of nature and knowledge of propagation of plant life seem to me to have been the forces behind the development of the upright variety of barberry. I am not prepared to accord invention to the result produced by such uses in respect of the upright barberry; but if it were otherwise, the fact of the knowledge and existence of the plant prior to the amendment of May, 1930, and its prior public use, would fatally impair its validity.

The transaction of August 12, 1931, whereby one Endress transferred to the plaintiff some eight thousand erect barberry plants which had been in his possession since 1929, gives much support to the defendants' claim of fatal public use,—the date of the transaction being more than two years prior to the application of Horvath and prior to the approval of the amendment in respect of the plant patents.

There is evidence that Horvath had fully developed his plant as early as 1924, and from the other evidence I am persuaded that the plant was introduced to the public prior to May 23, 1930.

Nor can one ignore the disinterested evidence of Woolworth employees as to sales

of upright barberry plants by them in the springs of 1932 and '35.

Upon due consideration of the issues, and in view of the existence and public use of characteristic upright barberry prior to the approval of the Act of May 23, 1930, and of the other considerations mentioned, judgment may be entered for the defendants, and Bill dismissed.

Findings and conclusions may be submitted for consideration and adoption.

As a test case to clarify certain important questions regarding the Plant Patent law this decision leaves much to be desired. The fact that the plant in question was commercially distributed before the enactment of the law is a technicality which might well have been evoked by the Patent Office to reject the application before the patent was issued in the first place. The liberality shown in this respect by the Patent Office is perhaps unkind in the long run to patentees, because prior use automatically invalidates a patent, and the plant patent amendment specifically states in regard to this point that "no variety of plant which has been introduced to the public prior to the approval of this Act shall be subject to patent."* There is, however, a question of what constitutes "prior use" of a plant. It is necessary to test a new plant form before it is possible to decide whether it is of value. Thus the mere existence of a plant more than two years before patent was granted could not fairly be alleged as prior use according to horticultural practice. Whether precedents from mechanical practice will take this fact into consideration in interpreting the Plant Patent law remains to be seen.

Several instances of possible "prior use" appear among the patents so far issued. Thus one of the patented plants was produced in 1907, and has been under test ever since. Did this constitute "use" in the legal sense? Another of the patented plants won several medals two years before the plant patent amendment became law. Did that constitute "use"? A number of patents have been granted to the estate of the late Luther Burbank, six years after Burbank's death, and over two years after his "plant estate" had been sold. The parallel between this situation and the Endress transaction cited in the Horvath decision seems close enough to raise a question of the validity of these patents.

Leaving the implications contained in the "asides" regarding asexual propagation and invention, in the fifth and sixth paragraphs in the decision it appears from an examination of the specifications that the following "patents" existed prior to the enactment of the plant patent amendment, some of which may be invalid on the basis of the Horvath decision:

Plant Patent 3. A carnation discovered by the "inventor" in 1929. It had not been offered for sale prior to the enactment of the Plant Patent Act, according to the specification. The question of prior use would therefore seem questionable in this case.

Plant Patent 4 would seem to be in considerably greater jeopardy. According to the specification, the "inventor furnished specimens in 1928 to George M. Darrow who, at that time was Senior Pomologist of the Bureau of Plant Industry of the U. S. Department of Agriculture, and who later wrote an article entitled "Thornless Sports of the Young Dewberry" that was published in the JOURNAL OF HEREDITY for December, 1929, pp. 567-569, in which he listed the identical mutation of the young Dewberry that was found by us in 1928 and furnished to

*The sections of the patent law bearing on this point are as follows: "Sec. 4884. Every patent shall contain a short title or description of the invention or discovery, correctly indicating its nature and design, and a grant to the patentee, his heirs or assigns, for the term of seventeen years, of the exclusive right to make, use, and vend the invention or discovery (*including in the case of a plant patent the exclusive right to asexually reproduce the plant*) throughout the United States and the Territories thereof, referring to the specification for the particulars thereof. A copy of the specification and drawing shall be annexed to the patent and be a part thereof."

"Sec. 4888. Sec. 5. Notwithstanding the foregoing provisions of this Act, no variety of plant which has been introduced to the public prior to the approval of this Act shall be subject to patent."

him." Whether this description published long before the enactment of the Plant Patent Amendment will constitute publication and invalidate the patent under the current decision may be questioned. Prior publication combined with the furnishing of specimens two years before the enactment of the Plant Patent Act would seem hazardous in the light of the above decision.

From the specification of Plant Patent 6: "The enclosed seedling was first discovered about the year 1929, and has since been propagated and developed. It is briefly described on page 320 of the 1930 edition of the American Rose Annual, published by the American Rose Society, Editorial Offices, Harrisburg, Pa." Whether this listing would constitute publication or "introduction to the public" prior to the enactment of the Plant Patent Act remains to be seen. No statement regarding distribution prior to the Act appears in the patent.

Plant Patent 9. "The improved seedling was first discovered by myself during or about the year 1929, and has since been propagated and developed. It is registered at the Office of the American Rose Society." Here again a shadow of doubt might exist.

Plant Patent 11. This patent possibly offers an interesting point, being one of the "joint invention patents" which have been discussed before in the JOURNAL. "This new rose was first discovered as a sport by the first named of the joint inventors during the year 1929. The second named joint inventor fostered and developed the plant, studied its characteristics, and asexually reproduced it by budding." The question might be half humorously raised whether the discovery by the first joint inventor and the propagation by the second joint inventor did not constitute distribution prior to the Plant Patent Act. Obviously it was a "partial distribution," at least, because in consideration for his horticultural skill it seems that the second joint inventor was rewarded by being presented with an equal share in the patent.

Plant Patents 12-15, 18, 41, 56 are the "Burbank Patents" which were granted to the Executrix of the Burbank Estate, Elizabeth Walters Burbank, and assigned to the Stark Brothers Nurseries of Louisiana, Mo. These hybrids were made by Luther Burbank, who died in 1926, four years before the Plant Patent Law was enacted. During this period the entire collection of fruit tree hybrids was sold by his estate to the Stark Brothers Nurseries. Thus the plants which were the subjects of the Burbank Patents had changed hands a very considerable time before the Plant Patent Amendment became law. Whether this would constitute "use" or "sale" more than two years prior to application for patent would remain to be seen. It would seem, however, to constitute a fairly clear case of "prior sale." Certainly nothing inventive was done to the plants subsequent to the act except to test them further and to offer them for distribution (if they have been so offered). There would seem to be no doubt that the plants which are the subject of the Burbank Patents were in existence years before the Plant Patent Law was enacted. Here again there is a question of interpretation which the courts would have to decide.

Plant Patent 17 appears to be for the same Giant Freesia which was the subject of an article in the JOURNAL in 1928. In addition, we quote from the specification: "The variety was awarded a gold medal when first exhibited as a new variety and novelty at the National Flower and Garden Show of the Society of American Florists and Ornamental Horticulturists in Louisville, Ky., in 1928. This variety was not introduced and sold to the public until the fall of 1930. Apparently "publication" insofar as that is possible with a plant, took place two years before the law was enacted, and its public exhibition would seem to constitute "use" in one sense. Whether such publication and public exhibition more than two years prior to application for patent would invalidate the patent remains to be seen.

Plant Patent 22 was "first discovered by me on or about April 15, 1929.*** My new rose variety was registered with the American Rose Society in 1931." There is possibly a question here.

Plant Patent 26: "was taken up in early June, 1926, from the edge of a two-year Glen Mary fruiting row with other small seedlings when each seedling did not have more than three small leaves and transplanted in a cold frame, grown therein for one year and then planted in a test plot where its characteristics, as a worthy commercial variety, were first noted. It has been tested and grown in fruiting rows during the spring strawberry seasons of 1929, 1930, and 1931." The origination of the patent four years before the act seems rather a long time, but if no plants were distributed this may have constituted no barrier to grant of a valid patent because of the time factor.

Plant Patent 32 has an interesting history. "After reproducing this new variety (of Freesia) for several years and testing it to make sure of its superior qualities, I sold the entire stock of this variety in the fall of 1930 to Mr. J. C. Van Bourgondien, of Babylon, New York, who took this stock to his home in New York State, and as late as August, 1931, still owned and possessed the entire stock." The application for patent was filed January 13, 1932, several months after the stock had been sold. While the question of use prior to the enactment of the act does not figure here, there might be a question about the sale of the patented article prior to application for patent.

Plant Patent 33 also has interesting possibilities in connection with a new variety of rose: "The first cut blossoms were offered for sale in September, 1931. None of the plants have yet been offered for sale." The application for patent was filed January 23, 1932, and the claim states that it covered a hybrid tea-rose substantially as shown and described. There again discovery prior to the Patent Act, and sale prior to application, might seem to offer complications.

The variety covered by Plant Patent 34 was produced as a cross in 1928 but was not distributed.

Plant Patent 44 offers the same situation as Plant Patent 32.

Plant Patent 46 involves a strawberry with a long history before the Act was enacted. The patent is granted to Oliver C. Cordrey and Ernest W. Townsend. In 1925 Mr. Cordrey pollinated some strawberries by hand and produced a hundred seeds. Mr. Townsend took over the seedlings as they sprouted and carried on the rest of the processes leading up to the production of the new variety. These according to the specification included "study, selection, development, and asexual propagation." Mr. Townsend then developed the variety from 1925 to 1931, when it was first offered for sale to the public. Application for the patent was filed on March 31, 1932. Thus any invention involved in the production of this new form took place fully five years before the enactment of the Plant Patent Amendment. The person who produced the inventive part of the undertaking then turned over the plant to a man who used only horticultural skill from then on. This would almost seem to constitute sale rather than joint invention. Here again there seem to be arguments on both sides.

Plant Patent 49 claims a new rose which appeared as a bud mutation in 1928. It was not sold prior to the enactment of the Act.

Plant Patent 51 is also a joint invention patent. The variety was discovered by the "first named of the joint inventors" in 1927. "Since that date this new variety has been observed, tested, and reproduced by the second named joint inventor. The first peaches from topworked trees were produced in 1930, and those from grafted trees were harvested in 1931. Here again the question of joint invention enters and one wonders whether this chain of events really constitutes joint invention as alleged, or sale prior to the issuance of the patent.

Plant Patent 71 has an especially interesting history, tracing back to a hybrid produced in 1907 between the Howard 17 and Howard 103 strawberries. The plants were grown in 1908, and in 1909 the variety which is the subject of this patent was selected. The inventor tested it several years, and then distributed it to a number of the leading experiment stations for testing purposes. It was stipulated when the plants were sent out that they were distributed solely for testing and that they were not sold to the stations, nor were the stations allowed to sell plants to others. The variety was introduced and sold to the public January 1, 1931, when it was offered in a catalog of the E. W. Townsend Nurseries of Salisbury, Maryland. The original application was filed on July 1, 1931, six months after the plants were offered for sale. The existence of the variety a quarter of a century before the law was enacted is admitted. Such prolonged testing as was practiced in this case is an important part in the production of varieties by conscientious breeders. The value of the Plant Patent Act as an aid to plant breeding would seem to depend on maintaining the right of an inventor to carry on such tests prior to obtaining patent. Whether this could be done prior to the enactment of the Plant Patent Amendment would seem to be a question.

Plant Patent 73 represents a pecan tree found growing wild on the land of the Humble Oil Co. of Texas in 1928. The "inventor," that is, the person who found the tree, assigned the patent to the Company on whose land the tree was found. The question of whether a mere find represents invention seems more important in this case than the time sequence involved.

* * *

It would thus appear that of the Plant Patents so far issued a significant number of the early ones may be rendered of doubtful validity by this decision. The circumstances in many cases are so different it is obvious that with few exceptions interpretation allows enough latitude so that this decision would not necessarily invalidate many of these patents. The cases cited above are culled from the printed specifications. Other questionable cases might be found by reference to the "jackets" which contain the correspondence, etc., relative to issued patents. These data become accessible to the public when a patent is issued. In those cases where the plants existed for a long time prior to the enactment of the act, if distribution can be proven, the validity of the patent seems to be unquestionable. What constitutes distribution and publication is not so clear. The matter is a little different in plants than in mechanical patents because a plant patent

cannot be "disclosed" as can a mechanical patent so that any person can make the device who has in his possession the "disclosure," or one of the patented devices. Thus when he sells all of his stock of a new variety, the "inventor" entirely loses control of his new form, which he would no longer be able to produce or reproduce. This seems to bring a new principle into patent law. The question of how many times title may change before an invention is patented would seem to be one that might prove troublesome not only in these cases but in many others.

Abstrict vs. Concrete Plant Patents

With respect to the question of validity of existing and forthcoming plant patents, some of the "asides" in this decision may be more important than the main argument. Paragraphs 3 and 4 of the decision, while they are distinctly secondary in this case, would seem to be of very considerable importance with respect to the Patent Law as a whole. It would appear to be held in Paragraph 4 that if cuttings or other propagating material were not obtained from the plants covered by the patent, no infringement existed. That is, it would seem to be the view of the court in this case that plant patents under the present statute represent in effect clones, i.e., the asexual progeny of a given plant. If this reasoning is upheld in later decisions it follows that a plant patent under the existing act represents a *biological entity* rather than a *verbal abstraction* outlined with doubtful completeness in the specification and almost defying exact definition.

It has already been suggested* that this "clone" view represented about the only practical and workable method of plant patent administration. This principle, enunciated more or less obliquely in this case, would seem to have a very important bearing on the question of basic patents, which has been under discussion recently in the JOURNAL. Obviously basic plant patents are out of the question if this concept is maintained by the courts. It would seem impossible under such a ruling to obtain court sanction for the view that nasturtiums arising from "Miracle Mixture Seeds" could be covered by a plant patent, unless it could be proven that the seedlings so produced were apogamic, — that is, that they were actually vegetative buds and not seeds in the usual sense. Neither would it seem possible to patent a "genetic type" to be transferred at will to a number of varieties.

What Is a Plant Invention?

Paragraph 5 has even more momentous implications in the statement that in order to maintain the validity of a plant patent, the courts must be able to "accord invention to the result produced." The question of what constitutes "plant invention" is most important and crucial in determining the scope of the plant patent law. It will inevitably be a question on which a later plant patent suit will hinge. In the Horvath patent the inventor claimed that through five generations he had practiced "a process of selection and genetics." If it is held that this does not constitute invention (as seems to be the case here), what of the large number of patents granted on sports and chance seedlings, admittedly purely sporadic occurrences over which the plant breeder has no control? If a "process of selection and genetics" does not constitute invention, how can merely finding a fortuitous form be held to constitute invention? When one reviews the present legal concepts of invention based on decisions extending over a hundred years, it is hard to see how the courts can do anything but add an emphatic "Amen" to the alarming implications of this first plant patent decision. This point is not vital in the case in question, but as a judicial aside it would seem to bode ill for

*Other Plant Patents, *Jour. of Hered.* 24:49-54.

patents on bud mutations and "mere finds." Since 88 out of the 200 patents thus far issued are for avowed bud mutations, finds or chance seedlings this principle, if upheld in later decisions, would seem to endanger the validity of a very considerable proportion of the existing plant patents.

Need to Revise the Law

There are such fundamental differences between plant breeding and mechanical invention that the attempt to form a biologio-legal hybrid between them seems fraught with needless difficulties. Genus hybrids are notoriously sterile, and indications are that this union of life and law is no exception. Just as design patents are dealt with under a separate statute, so should plant patents be considered to be distinct, having only a slight connection with mechanical and chemical patents.

The present situation can hardly be satisfactory either to the Patent Office or to the Department of Agriculture, which is charged by Executive Order with certifying to the novelty of varieties on which patents are claimed. Neither can the doubtful validity of many plant patents under the existing statute contribute very much to the useful art of plant improvement. Under such circumstances it would seem the better part of wisdom to plan immediately to revise the plant law before the whole idea of plant patents is discredited by later court decisions.

Several points in connection with such a revision of the law seem clear. In the first place, the attempt to graft plant patents onto the existing statute covering mechanical and chemical inventions is a grave error. Earlier articles in the JOURNAL have explained some of the profound differences between the origination of plant varieties and invention in the existing legal sense. These differences, which are inherent in the material we are dealing with, should be recognized by separating the plant patent law from the previously existing patent laws.

This separate plant patent law should codify the most useful and advanced features of existing practice with respect to origination and introduction of new varieties. As a single example, much of the value of a variety depends on the linking of a name with a distinct form. Under the existing arrangement, mention of the name of the new variety in the patent specification is forbidden,—a wholly useless and needless source of confusion.

The form which such a plant variety section of the Patent Office might take would require much cooperative study before final formulation. A few features which would seem to be essential are the following: (1) Creation of a separate division of Plant Patents, under the direction of a competent horticulturist, trained also in the fundamentals of patent law and patent procedure. (2) Provisions for registering new varieties under test. (3) The establishment of type gardens and a type herbarium where patented varieties and registered varieties might be preserved and maintained. (4) Since the progress of horticulture may be advanced by the use of chance finds and of spontaneous mutations, these should be eligible to patent—possibly for a shorter period than varieties arising as a result of planned plant inventions. (5) Clarification of variety definition in the law. If patent varieties are clones, that should be clearly stated. If a broader definition is attempted, there seems to be no reason why the law should be limited to asexually reproduced varieties.

If a carefully formulated plan for attaining the highly desirable ends aimed at in the plant patent law were presented to the Patent Office it should be welcomed, because the present situation borders on the absurd. A revision of the law drawn up by the leaders of the plant industries and bearing the approval of the Commissioner of Patents should receive sympathetic attention from the Committees on Patents of the

two houses of Congress. Such a course would seem to have considerable advantage over waiting until the virtual invalidation of the present law has discredited the plant patent idea, and then attempting to start over again. The devastating argument: "See what happened last time! It can't be done!" will be a drag that will be very difficult to overcome.

In the light of developments to date it is not too soon for interested parties and industries to give careful thought to what is needed in the way of adequate and workable protection for the new forms produced by plant breeders and horticulturists. It would seem to be an excellent gamble that from 70 per cent to 90 per cent of the existing patents will be declared invalid under the existing statute as soon as infringement suits give the courts an opportunity to have their say, and sooner or later this will certainly happen. The present decision gives ample warning of what is to be expected, and if those who should realize the need and who have most at stake are not willing to take so broad a hint, the courts are surely not to blame.

ROBERT COOK

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The Catalogus Plantarum of 1730

(*Continued from page 387*)

experiments not only in pharmacology, but to determine general uses for new plant introductions. Sir Henry Sloan appears as the pioneer patron of plant introduction, since he deeded to the Company of Apothecaries the Chelsea garden for this worthy purpose. Among early plant explorers should be included "Mr. Catesby of South Carolina," whose enthusiasm in plant introduction led him not only to send to England honeysuckles, ashes, and many other plants, but the poison sumac which is duly listed in the work in question and seems to have had a surprisingly favorable reception, considering its rather inhospitable nature.

In connection with early history of plant hybridization it is noteworthy that a guiding spirit in the production of this unique volume seems to have been Thomas Fairchild, who is credited with making the first plant hybrid—Fairchild's Mule Pink. Zirkle (*Jour. Hered.* 23:435-7) has done much to rescue this pioneer plant hybridizer from the oblivion into which he was shrugged in Sach's *History of Botany*. No mention is made of hybrids in the volume, but there are frequent statements regarding sex differentiation in the flowers of the plants discussed. Thus of the mulberry it is said (p. 50) "The male flowers (or katkins) are sometimes produced on different trees, and at other times at remote distances from the fruit on the same tree." Of the sea buckthorn (p. 63) it is said: "It hath the whole hybrid of the Rhamnus (or buckthorn) the male flowers (which are produced upon different trees from the fruit) are without visible leaves, having a cup consisting of two leaves in which are produced many stamina or threads." Many other references similar to this are made.

The series of remarkably fine colored plates, among the first example of colored printing on record (by the mezzotint process, in which the half-tone dots are made by roughening the surface of a copper plate), include a great variety of plants, some of them not mentioned in the book. This is the case with the double nasturtium illustrated herewith. Included in these plates are many plant introductions from widely separated regions of the earth—among them is Paraguay tea (mate), the candleberry tree, the honey locust, and many other American plants.

In breaking with botany by tradition, in stressing an appeal to the plants themselves, and in putting on the record the great importance of plant introduction as an aid to horticultural progress, the volume seems to deserve an important place in the history of pre-Linnaen botany.

R. C.

ABNORMAL UPPER MANDIBLE

A New Lethal Mutation in the Domestic Fowl

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SIX lethal genes, which cause death of the embryo or of the chick soon after hatching, have been reported in the domestic fowl. Of these, two cause death at an early stage in development. One of these is the lethal reported by Dunn[2] and detected only because of its close linkage with recessive white in a strain of White Wyandottes. The other is the Creeper gene. Landauer and Dunn[7] found that most homozygous Creepers die early on the fourth day of incubation while all Creepers that hatch are heterozygous.

A third lethal was reported by Byerly and Jull[1] to be usually fatal during the last three days of incubation. The entire skeleton is affected. Since the amniotic and allantoic fluids remain unabsorbed and are viscous and sticky the condition, which is caused by a single recessive gene, has been designated "sticky." Landauer[6] has also reported that several genes are responsible for shortening of the extremities in Dark Cornish and that one of the factors concerned in shortening of the long bones is lethal in homozygous condition. The affected embryos die towards the end of the incubation period or remain alive but are unable to hatch.

Two other lethals, which permit the affected individuals to hatch, have also been reported. In one of these, congenital loco, the head is pulled back and the chicks repeatedly fall backwards. Knowlton[5] has shown that it is a simple recessive. Chicks affected with congenital tremor, reported by Hutt[3] and Hutt and Child,[4] tremble when they stand. This also is probably recessive. Few of the chicks affected with either of these conditions survive.

Recently, in addition to these lethals, Upp and Waters[10] have presented data which indicated the presence of a sex-linked lethal in the strain of White Leghorns with which they were working. The sex ratio of dead embryos was about 1 male to 2 females.

Another lethal has been discovered in a flock of inbred Single Comb White Leghorns. The affected chicks occurred among the progeny of a hen (I 13) mated to her son and some of her daughters mated to this same male, their full brother.

Description

The upper mandible of affected chicks is abnormal. The maxillae of the upper mandible are absent or much reduced while the premaxillae (and egg tooth) are present and normal, or nearly so, in many affected chicks but are reduced in size in some cases. The nasals are also present but may be reduced in size in some of the affected individuals. The upper beak is frequently bent to one side. Since there is considerable variation (see Figure 3, *E* and *G*) other facial bones may be affected and the eyes of some chicks appear to be slightly reduced in size. The main effect, however, is on the maxillae of the upper mandible. Except for this and lesser effects on other facial bones, the chicks appear to be normal. The beaks of heterozygous birds look like those of homozygous normal individuals.

Few of the affected chicks were able to pip the shell. Only one hatched while seven other were removed from the shell. All died within one week.

The abnormality has been observed in embryos that died before the four-

NORMAL AND DEFECTIVE UPPER MANDIBLE DURING DEVELOPMENT
Figure 3

Embryos showing normal and defective mandibles at 15, 16, and 21 days of incubation. The *A* abnormal and *B* normal 15-day embryos; *C* normal, and *D* abnormal 18-day embryos; *E* and *G* abnormal, and *F* normal 21-day embryos. The latter (*E* and *G*) represent extremes in the development of this character. Under natural conditions this character is a lethal because the defective upper beak is not strong enough to break the shell, so that the chick is unable to hatch. Even though the shell is removed artificially chicks only survive a few days.

teenth day of incubation and in embryos removed on the twelfth day of incubation. Since (according to Lillie,[8] p. 433) the bones of the beak have begun to develop by the end of the ninth day of incubation it should be possible to classify the embryos at an early age. Figure 3 shows embryos with normal and abnormal beaks removed from the shell after 15, 18 and 21 days in the incubator. From observations made on younger embryos it is evident that the embryos with abnormal beaks can be easily distinguished from those with normal beaks at least as early as the twelfth day.

Inheritance

The incidence of the abnormality among the progeny of the eight hens from which some lethals were obtained is shown in Table I. While there is

TURKEY POULT WITH DEFECTIVE BEAK

Figure 4

Abnormal upper mandible in turkey poult removed alive from an unpipped egg at end of 28th day of incubation. This defect resembles exactly that found in fowl chicks, but nothing is known regarding its inheritance in the turkey. Similar defective upper beaks were observed among pheasants and partridge chicks, but here also no information is available regarling the genetic nature of the defect.

considerable variation among the progeny of the different hens, the totals for the entire group are almost exactly those expected on the basis of 3 normal to 1 abnormal. Moreover, it will be observed that the sex ratio does not deviate significantly from normal in either group. There can be no doubt, therefore, that the affected individuals are homozygous for a recessive, autosomal gene.

Of the twelve daughters of I 13 tested, seven gave some abnormal progeny (Table I) while five others did not produce any embryos with abnormal beaks. Two out of the five were definitely not carriers of the lethal gene, while the other three must be considered doubtful because of the small number of embryos available. The incubation data for the two groups (Table 2) show that comparatively fewer of the eggs laid by the carrier hens hatch than from the non-carriers. The difference is mostly due to the larger number of embryos that die during the last few days of incubation because of their inability to pip the shell.

The data available thus indicate that about half the progeny of I 13 carry the lethal gene. Several other White Leghorn hens, more or less closely related to I 13, were available but only three were tested by mating them to the same male that produced abnormal progeny when mated to I 13 and some of his sisters. No embryos with abnormal beaks were obtained from these three hens. Since none of the embryos from I 13 in 1935 were abnormal, it may be concluded that the male she was mated to was a homozygous normal. No data are available on embryos that died prior to 1935, but from the fact that 15 out of 29 embryos from the mother of I 13 died in the shell, it may be inferred that the mutation appeared in some ancestor of I 13.

Embryos with a similar abnormality have been observed in other species including Eastern Chinese Ring neck pheasants, Mongolian pheasants, Indian Chukar partridge, and domesticated bronze turkeys.* The abnormality as it was observed in these species resembles that shown in Figure 4, the beak being more nearly normal than the majority of the affected chicken embryos (but compare with Figure 3, *G*). Embryos were also observed with only one maxilla, or one side of the upper mandible affected. No data are available on the inheritance of the abnormality in these species, hence its occurrence may be purely fortuitous.

Discussion

The effects of the gene described in this paper appear to be less extreme

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than others that prevent hatching in the domestic fowl (Byerly and Jull,[1] Landauer[6]) or the duck (Rüst[7]). Moreover, it appears to have little or no effect on the viability of the embryo up to hatching time but does handicap those that hatch or are removed alive from the shell. It may be expected that some would survive if enough of the more nearly normal individuals could be removed alive from the shell or if hand feeding were resorted to.

Table I. Distribution of Individuals with Normal and Abnormal Upper Mandibles among the Progeny of ♀ 13 and Seven of her Daughters.

	Normal upper mandible Sex				Abnormal upper mandible Sex			
No.	Males	Females	unknown	Total	Males	Females	unknown	Total
♀ 13	14	17		31	6	1	1	8
♀ 12	1	4		5	1	1		2
♀ 36	5	14		19	3	2	2	7
♀ 44	3	1	3	7	1		1	2
♀ 68	26	15	1	47	11	0	2	21
♀ 91	3	4	3	12	2		2	4
♀ 93	5	6	2	13	1	2		3
♀ 100	17	20	2	39	4	6	1	11
Totals	78	84	11	173	29	30	9	68
Totals - expected (3:1)				173.25				57.75

Table II. Data on Fertile Eggs. Group 1 Comprised Eight Hens (See Table I) each of which Produced Lethal Embryos. Group 2, Five Hens which Produced only Normal Progeny.

Group	No. of Fertile eggs	Died 1-7 days	Died 8-14 days	Died 15-21 days	Hatched
		Per Cent	Per Cent	Per Cent	Per Cent
1	248*	5.0	9.0	37.1	49.0
2	67	13.4	9.0	14.9	62.7

* Includes 14 embryos that died before the beak had developed sufficiently to permit their classification as normal or abnormal.

The structures affected develop comparatively late in ontogeny. Soon after these structures have started to develop, the deformed embryos can be easily distinguished from the normal embryos by observation. This together with the good viability of affected embryos up to hatching time should make it useful for linkage studies where the other characters involved are controlled by genes fully expressed in late embryonic stages.

Summary

Embryos with deformed upper mandible were obtained from an inbred strain of White Leghorn chickens. The upper maxillae of affected embryos were absent or very much reduced while other facial bones were usually comparatively little affected. Only one out of 58 affected individuals hatched, the beak usually being too weak to pip the shell. Abnormal individuals can be readily distinguished from those with normal beaks by the twelfth day of incubation.

Abnormal upper mandible is a simple, autosomal recessive. The beaks of heterozygous birds look like those of homozygous normal individuals.

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AN ANTHOCYANIN INHIBITOR IN RICE*

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THE inheritance of anthocyanin pigments in various parts of the rice plant has been extensively investigated. Generally the colored character is dominant over the non-colored or green. So far as the writer is aware no case of an inhibitor of anthocyanin pigment in rice has been reported previously, except the writer's brief announcement of the present case.[14] In the present paper detailed results of the investigation are presented.†

Review of Literature

The presence of inhibitors has been discovered in both plants and animals. In plants, the classical case of the dominant inhibitor, *I*, of the aleurone colors in maize, discovered by East and Hays,[5] is well known. Shull[19] reported a gene inhibiting red color of flowers in Shirley poppies. Imai,[12] working with morning glory, *Pharbitis nil*, found a gene I^{h}_{1}, suppressing white margined carolla pattern. White,[26] reports an inhibitor of cotyledon color in Pisum, giving a ratio of 13 yellow to 3 green.

In rice, Parnell *et al*[17,18] found a suppressor of golden color of lemma and palea which turned them into "dark-furrowed." Woodworth[27] in summarizing the genetics of soybeans mentions a series of alleles inhibiting coat colors. The dominant gene is fully epistatic, suppressing coat colors entirely. The recessives, however, produce imperfect suppression. Very recently Stroman[21] has reported a very interesting case in cotton. A gene inhibits color in anthers when either one of the two pigment genes for yellow and white anthers is present. But in the presence of both the genes the inhibitor is powerless.

Not only color but morphological and physiological characters are suppressed by inhibiting genes. Clark and Hooker,[1] Clark and Quisenberry,[2] Goulden,[7] Stewart and Tingey[20] and Tingey[24] report dominant inhibitors of dwarfness in wheat, giving 13 normal to 3 dwarfs. In the same crop plant, Thomson[25] has found an inhibitor of the inhibitor of dwarfness. In barley, Ikeno[9,10] and Hor[8] have reported suppressors of awns in the lateral florets and of broad glumes respectively.

Cooper[3] reports a case of a gene suppressing winter habit of growth in wheat. Dietz[4] mentions a case of an inhibitor suppressing stem-rust resistance in oats.

Material and Methods

The investigation was conducted at the Rice Breeding Station, Karjat, Kolaba, in the Bombay Presidency.

The two varieties, *Nagkeshar* and *Ratanghose* are pure lines and have been grown for several years at the station. *Nagkeshar* was obtained from the Central Provinces. It is colored all over the body, giving a dark-purple appearance in the green stage. When dry, the straw is bronze-yellow. The anthocyanin pigment commences to develop as soon as the seedling emerges. In the early stages the plants appear greenish-dull-red, but gradually become full purple as the pigment extends all over the leaf blades and other parts of the plant. The presence of pigment probably makes the leaves brittle in this variety. The palea and lemma are color-

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less but the outer glumes are colored. The kernel is white. The variety is tall and poor in tillering.

The other variety, *Ratanghose,* is entirely green and dwarf. It tillers profusely. The fruit is small and the kernel white. Its original home is said to be the Jawahar state in the Thana district of the Bombay Presidency.

Both the varieties flower in 114 days from the time of sowing. Crosses were made during the season of 1930. *Nagkeshar* was used as a female parent as it has larger flowers which are easy to emasculate. The flowers of *Ratanghose* are very small and difficult to emasculate.

The F_1 plants of ♀ *Nagkeshar* × ♂ *Ratanghose* were tall and with green leaves and red sheath, unlike either variety. In 1932 an F_2 generation was raised. In the regular season of 1933 F_3, and in the summer of the same year, F_4 generations of purples were grown to determine the genetic constitution of F_3 families.

The statistical evaluation of the experimental results has been made according to Fisher's methods[6].

Experimental Results

The F_1 plants of ♀ *Nagkeshar* × ♂ *Ratanghose* were green leaved with colored sheath, unlike either parent. Evidently anthocyanin pigment in leaf blades was suppressed in the F_1 plants.

From a protected F_1 plant an F_2 generation of 508 plants was raised. It consisted of 86 purple and 422 green plants. The F_2 purple plants were colored all over like the *Nagkeshar. En masse,* however, they were not so intense in color as the parent. The green leaved F_2 plants consisted of entirely green plants and of red-stemed plants with green leaves. The ratios of these types were 9 red stemmed, green leaved; 3 purple: 4 entirely green. Since we are considering only color in the leaf blade region the first and the last classes are combined. This gives a 13:3 ratio. On this basis the expected frequencies are 95.25 purple and 412.75 green-leaved plants. The deviation of 9.25 plants gives a probability between 0.30 and 0.20 for $\chi^2 = 1.1054$ and $n = 1$. The agreement between theoretical and expected values is thus satisfactory, the observed probability being over the 5 per cent point.

The F_2 generation indicated that we are probably dealing with a specific inhibitor of anthocyanin pigment in the leaf-blade region. On this assumption

Table I. F_2 green plants with red-sheath segregating into green and purple leaved plants in a 12:3 ratio in F_3

F_2 No.	Observed		Expected	Dev. ±	Total	χ^2	For n = 1 P.between
	Green	Purple	Purple				
31	64	16	15.0	1.0	80	0.0819	.80 & .70
136	70	13	15.6	2.6	83	0.5336	.50 & .30
172	94	16	20.6	4.6	110	1.2637	.30 & .20
194	78	16	17.6	1.6	94	0.1789	.70 & .50
201	88	21	20.4	0.6	109	0.0216	.90 & .80
379	77	27	19.5	7.5	104	8.5802	.10 & .05
392	97	16	21.2	5.2	113	1.5699	.30 & .20
431	94	15	20.4	5.4	109	1.7585	.20 & .10
Total	662	140	150.3	10.3	802	0.8685	.50 & .30

Table II. F_2 green plants with red-sheath segregating into green and purple leaved plants in a 3:1 ratio in F_3

F_2 No.	Observed		Expected	Dev. ±	Total	χ^2	For n = 1 P.between
	Green	Purple	Purple				
254	81	10	22.75	12.75	91	9.5274	Over 0.01
443	86	25	27.75	2.75	111	0.3633	.70 & .50
Total	167	35	50.50	15.50	202	6.3425	.02 & .01

Table III. F_2 purple plants segregating into 3 purple : 1 green in F_3

F_2 No.	Observed		Expected	Dev. ±	Total	χ^2	For n = 1 P.between
	Purple	Green	Green				
294	60	16	19.00	3.00	76	0.6316	.50 & .30
296	66	21	21.75	0.75	87	0.0344	.90 & .80
299	68	32	25.00	7.00	100	2.8133	.20 & .10
310	52	17	17.25	0.25	69	0.0048	.95 & .90
311	72	19	22.75	3.75	91	0.8241	.50 & .30
327	58	23	20.25	2.75	81	0.4978	.50 & .30
331	38	17	13.75	3.25	55	1.0041	.50 & .30
344	59	21	20.00	1.00	80	0.0666	.80 & .70
506	65	27	23.00	4.00	92	0.9274	.50 & .30
508	70	23	23.25	0.25	93	0.0035	.98 & .95
510	61	20	20.25	0.25	81	0.0040	.95 & .90
519	55	20	18.75	1.25	75	0.1110	.80 & .70
521	62	22	21.00	1.00	84	0.0634	.90 & .80
Total	786	278	266.00	12.00	1064	0.7217	.50 & .30

it was expected that among the purples and greens would be found pure breeding plants and also plants whose progeny would segregate into purple and green leaved plants. This assumption was substantiated by the breeding behavior in F_3.

As stated above there were two types of green-leaved plants in F_2, entirely green and colored in sheath region. The former bred true, i.e. gave only colorless progeny in F_3. The latter, consisting of 15 families, were separated on the basis of F_3 progeny counts into three classes: (1) true breeding, and plants where progeny segregated (2) in a 3:1 ratio and (3) in a 13:3 ratio of greens and purples.

Table I summarizes the breeding behavior of families showing 13:3 ratio of green and purple plants. It will be seen that the deviations range from one to seven plants. In all cases the values of χ^2 are below that of 5 per cent significant level. The total of all the eight families agrees well with the expected numbers.

In Table II progeny behavior of the two monogenic families is recorded. Family 443 shows a good agreement. The other family, however, shows very wide departures from a 3:1 ratio. On the basis of a 13:3 ratio the agreement is better, the deviation being of only 7 instead of 13 plants. But the pure breeding behavior of the purple plants in F_4 clearly indicated that the family was monogenic, being heterozygous for the inhibitor, but pure for the anthocyanin gene.

It has been stated above that the genotypes of the F_3 families were determined by growing the F_3 purple plants in F_4. It was indeed impossible to separate the mono- and digenic F_3 families due to the closeness of the ratios and due to small numbers, except by breeding behavior. The purple plants from the digenic families both bred pure and segregated, while those from the monogenic families bred pure only. Thus, although Family 154 shows a very bad agreement with theoretical expectation, its subsequent breeding behavior without doubt revealed its true genetic nature.

There were five families which gave only green-leaved progeny with red stems. Thus the 15 F_3 red stemmed, green leaved families resolved into 5 homozygous, 2 monogenic and 8 digenic. The theoretical genotype frequencies are 5:3.33:6.67 respectively. The agreement is very close, giving a probability between 0.70 and 0.50 for a $\chi^2 = 0.8000$ and $n = 2$.

The purple F_2 plants were expected to breed true and to segregate into 3 purple to 1 green. Out of the 19 purple families grown in F_3 six were homozygous, the remaining 13 proving monogenically heterozygous. The agreement with the expected 6.3 pure and 12.7 heterozygous is excellent.

The breeding behavior of the 13 heterozygous families is given in Table III. It will be seen that all the families show good agreement with the expected behavior. The grand total of all the families also shows a good agreement.

Discussion

From the foregoing experimental evidence it is clear that there is an anthocyanin gene which produces pigment all over the plant and an inhibitor which restricts the development of color in the leaf-blade. The genes are designated *A*, the anthocyanin gene, and *I*, the inhibitor. The purple plants are due to the action of *A*. The F_2 heterozygous purples segregate into purple and entirely green plants in a monogenic ratio indicating that *A* alone is capable of making the whole plant purple. When both the genes are present the plants have green leaf-blades, but are colored in other parts. Thus, *I* inhibits development of anthocyanin pigment in the leaf-blade region only.

The inheritance of purple plant color has been reported previously in Japanese rices. Kato, according to Ikeno,[11] found dominance of purple and a 9:7 ratio of purple to green in F_2. The results of Takezaki (*cf* Ikeno)[11] and

Jones,[13] who worked with Japanese rices, indicate complementary tri-genic inheritance of 27 purple: 37 greens in F_2. Nakayama,[16] however, found a monogenic ratio of 3 purple to 1 green.

Ikeno states that in the purple varieties used by Kato and Takezaki the color in all the parts was inherited in a group so that there were no individuals which were purple in some parts and green in others. Jones[13] and Nakayama[16] mention also inheritance of some colored parts in groups. These results are similar to those of the writer.

The presence of a specific inhibitor indicates that some rice varieties, which are pigmented in specific parts but have green leaf-blades, may be genetically purple.

Summary

An anthocyanin gene, *A*, produces pigment all over the plant, making the plants entirely purple. The action of *A* is limited by a partial inhibiting gene, *I*, which suppresses color in the leaf region, but allows development of pigment in other parts.

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